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ABSTRACT

Whenever a new syllabus is introduced in an educational system, it introduces a number of new features, such as aims, goals and objectives, content, teaching orientation, and assessment strategies. It also has resource implications. This was the case with the introduction of Botswana General Certificate Secondary Education (BGCSE) science syllabi in 1997. The purpose of this study was to find out the extent to which the learner-centered approach in BGCSE syllabi was being implemented in the senior secondary school science lessons. From a population of 27 senior secondary schools in Botswana, the study was carried out in 18 schools. In each school a sample of 3 science classes was selected. With prior arrangements with each teacher, a 40-80 minutes lesson was video-recorded and later analyzed. The results of the study showed that most science teachers do not implement the recommended teaching orientation, teaching methods, and assessment procedures. (Contains 45 references.) (Author/YDS)

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TOWARDS LEARNER-CENTRED APPROACH IN SENIOR SECONDARY SCHOOL SCIENCE LESSONS

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Abstract

Whenever a new syllabus is introduced in an educational system, it introduces a number of new features, such as aims, goals and objectives, content, teaching method and teaching orientation and, assessment strategies. It also has resource implications. This was the case with the introduction of Botswana General Certificate Secondary Education (BGCSE) science syllabi in 1997. The purpose of this study was to find out the extent to which the learner-centred approach in BGCSE syllabi was being implemented in the senior secondary school science lessons.
From a population of 27 senior secondary schools in Botswana, the study was carried out in 18 schools. In each school a sample of 3 science classes was selected. With prior arrangements with each teacher, a 40-80 minutes lesson was video-recorded and later analysed. The results of the study showed that most science teachers do not implement the recommended teaching orientation, teaching methods and assessment procedures.

Introduction

The orientation of the traditional teaching that characterised the old Cambridge Overseas School Certificate (COSC) science syllabus in colonial and post-colonial Africa was mainly teacher-centred. Its major emphasis was to provide learners with assumed body of knowledge deemed necessary pre-requisite for tertiary education and technical fields. For this reason, it was assumed that the most effective way of passing on the knowledge to learners was by lecture method in which teachers played the central role of the learning /teaching process. In a way the teaching approach was said to be teacher-centred. So a typical science lesson was dominated by a teacher-talk accompanied by a few selected demonstrations and interrupted by questions from students. The students were passive participants and intermittently would be permitted to carry out confirmatory experiments. Towards the end of senior secondary education, students were given opportunity to carryout practical exercises as they prepared for the final practical examinations. This was a mockery of the whole issue of practical work in science subjects. Teachers drilled students in carrying out practical work in preparing them for taking examinations. One wonders whether students ever benefited from such practical work, as they would soon forget the process skills after taking the examinations. This lack of mastery of process skills was reflected in students' failure to handle simple equipment in first year science courses at university and college levels of education. Most first year students failed to handle sophisticated microscopes; electron balances and to prepare molar solutions.

In the Old COSC, secondary school students did not acquire the process skills of observation, interpretation, investigation, measurement, hypothesis, raising questions-considered necessary component of science. Nor were they involved in planning their own experiments and testing hypotheses. They were deprived of the creativity, inquiry, problem solving and several other scientific skills that characterise scientific enterprise. It was assumed that such skills would be acquired at tertiary level of education, a serious mistake because not many school leavers take science professions or careers, yet they need the same skills for survival in life.

In Botswana as in most independent African countries, the desire to change the colonial school syllabi was expressed soon after obtaining independence in 1966 (Republic of Botswana, 1977, 1993, 1994). The change in the syllabi was comprehensive including the philosophy, rationale, programme features, programme aims and objectives, programme content and structure, teaching methods and orientation and assessment. The change was made in stages, the Pure Science (Biology, Chemistry, Physics) was introduced in 1997 and Single Science and Double Science in 2000 (Yandila, 1999). Each of these three types of syllabi insists on learner-centred teaching approach as stipulated in the Curriculum Blueprint (1997).

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The new syllabi involve emphasising science process skills, problem solving skills, and the acquisition of hands-on experience that should increase the performance of all groups of different student abilities. The syllabi also stipulate that teachers should use a learner-centred approach of teaching by using a variety of methods including demonstration, practical work, field trips etc. In order to facilitate a learner-centred approach there should be pre-planning of activities and adequate working space. The syllabi also stipulate that teaching methods should expose learners to practical applications of science in everyday life. Local environment should be used to provide context to the syllabus. Teachers should present science in an interesting and challenging way that should popularise it and encourage learner to opt to pursue science and science-related careers (Senior Secondary School Science Syllabus, 1997 p.iii).

The new syllabi also insist that students should be actively involved in learner-centered practical work that emphasizes the process skills of using and organizing techniques, apparatus and materials, observing, measuring and recording, handling experimental observations and data and planning investigations. These skills transcend every topic in each syllabus and are to be assessed throughout the course and examined in the final practical examinations. It is therefore, assumed that students will need these skills wherever they go-science fields, technology, industry or as common citizens.

Definition of Learner-centred Approach

Scholars have defined learner-centeredness in a number of ways. For example, McCombs and Whisler (1997), define it as a perspective that couples a focus on individual learners with a focus on learning. Focusing on individual learners implies looking at their heredity, experiences, perspectives, backgrounds, talents, interest, capacity and needs. Over the years, education psychologists and educators have acknowledged the individuality of every learner, their learning styles and multiple intelligence (Piaget, 1956; Slavin, 1994; Vygotsky, 1978, 1987; Visser, 1993; Armstrong, 1994). They have argued that the most meaningful learning takes place in children if the learning environment encourages self-motivated and self-driven learning. To McCombs & Whisler (1997), learning is associated with the best available knowledge about learning and how it occurs and about teaching practices that are most effective in promoting the highest levels of motivation, learning and achievement.

Purpose of the Study

Now that the learner-centered approach has been introduced in Botswana schools, some question are; To what extent is this learner-centered approach being followed by science teachers in classes? Do teachers experience problems when they implement this new approach? Do students accept the learner-centered approach? And do they learn more effectively through this approach? Do teachers teach the prescribed processes of science through learner-centered approach? The purpose of this study was to find out the extent to which the learner-centered approach was being implemented using the four major process skills in the senior secondary school science lessons. Answers to the following questions were sought from the study:

1. To what extent are science teachers teaching the new science syllabi as stipulated in the Curriculum Blueprint and syllabi themselves?
2. What type of lesson orientation is taking place in the class?
3. What evidence of adequate pre-planning for learner-centered approach activities is shown in the class?
4. What kind of evidence that mixed-ability teaching is taking place in the lesson?
5. What forms of differentiated teaching/learning approaches are science teachers employing in the lessons?
6. Do teachers use a variety of teaching methods in the course the lesson?
7. Is there evidence of increased participation of all groups of learners in the lesson?
8. Do teachers make effort to inculcate the following recommended processes skills in students:
    - planning investigations?
    - using and organizing apparatus and materials,
    - Collecting data
    - handling experimental observations and data
9. Do the teachers carry out demonstrations before allowing students to carry out their own group or individual practical work?
10. Do teachers effectively use a variety of teaching aids in their lessons?

Significance of the Study
It is hoped that the results of this study will be helpful in a number of ways:

1. To provide useful information for the preparation of pre-service teachers for teaching practice exercise.
2. To serve as a basis for comprehensive investigation to redress problems in the implementing the new science syllabi.
3. To provide empirical basis for guiding the revision of the new science syllabi.
4. The videotapes themselves would be a rich source of exemplary lessons to be used in pre- service and in-service science teacher education.

Research Design
This was a case study looking for actual implementation of the new syllabus in a particular science class. It is a non-participant observation using a video camera to collect data. Several researchers have developed different instruments to record classroom observations including Flander (1970), Simon and Boyer (1975), Cohen (1976), Galton (1978), Wragg and Kerry (1978) etc. As Bell (1999) concedes, "...inspite of all the tried-and-tested methods that have been employed by the experienced researchers over the years, there never seems to be an example that is unique right for the particular task. Inevitably, you will find you have to adapt or devise a completely new approach, and all new systems need careful piloting and refining in the light of experience.... You will probably need to invent your own system of shorthand symbols and these will have to be memorized. You will need to decide how often to record what is happening (all the time? every three seconds? every five minutes? Every twenty minutes?) and with whom (all the group? Individuals?" (P.164). In this study, video recording took place during the entire 40-80 minute lesson duration. Trained researchers handled it.

Literature Review
A number of studies have been undertaken to determine if classroom teaching and learning activities is a correct reflection of the syllabus prescription. These include the work by Rantabe (1992) in primary school science, Tabulawa (1996) in Junior Secondary School Social Studies, Ramorogo (1994) in Junior Secondary School Science and Prophet and Rowell (1993) in Junior Secondary School Integrated Science.

To the best knowledge of the investigators, only four studies have been reported in the literature since the new science syllabi were introduced in the senior secondary schools. Yandila (1999) and Rammung (2000) carried the first two. Yandila investigated the implementation hiccups of the new biology syllabus in selected senior secondary schools in Botswana. The study employed a questionnaire. Respondents were asked to suggest reasons why they were unable to successfully employ the recommended teaching methods in biology. Forty-seven dully-completed questionnaires were returned and analyzed. Teachers cited several reasons for not employing the recommended teaching methods and some common reasons were:

- Teaching large classes
- Having large teaching loads
- Lack of adequately trained laboratory assistants.
- Lack of exemplary teaching materials
- Inappropriate text books
- Absence of relevant teaching and learning aids.
- Lack of understanding of the breath and extent of the new topics such as biotechnology.
- Lack of incentives and reward for teaching the new biology syllabus statement.
- Feel grieved for being inadequately consulted during the design and development of the new biology syllabus.
- Fears and misunderstanding expressed by students on the implications for sitting for core alone or core plus extension for final examination in form 5.
- Inadequately prepared to teach the new Biology syllabus.
- Inadequately prepared to carryout continuous assessment.
- Not provided with sufficient orientation in appropriate teaching methods.

The major disadvantage of these results was that only biology teachers in the Gaborone schools were contacted. It was expanded in the next study carried out by Rammung (2000) whose purpose was to find out the coursework assessment practices in the new senior secondary school Pure Science-Biology syllabus. It sought answers to questions such as: (i) Have teachers been keeping the records of students' performance? (ii) Do the coursework marks predict the examination grades of students at the end of secondary education? (iii) Why hasn't the coursework assessment been introduced in schools as stipulated in the new syllabus? The study comprised three schools from villages around Gaborone and those selected were past and present Pure Biology students and current Pure Biology teachers. The results showed that the new assessment method had not been introduced as yet but efforts were being made to do so. Teachers gave different reasons for not teaching the biology syllabus according to its recommended methods, but the common reasons were identical to those established by Yandila (1999), presented earlier.

Yandila (2001) carried out a study to find out the extent to which senior secondary school teachers were employing the recommended teaching methods and approaches in teaching Pure, Double and Single Sciences. The study involved classroom observation using a checklist whose content was based on the prescribed teaching methods and approaches. The Class Observation Checklist consisted of a fixed number of competencies listed in the new science syllabi. It was developed by drawing information from various sources, including the instruments used for assessing student teachers at the University of Botswana, in colleges of education in Botswana and literature such as Walters (1993), Duminy, et al (1992). Twenty-seven competencies were identified and placed into three major categories of Administrative, General Professional and Teaching. Administrative competencies related to planning and managing of teaching materials and consisted of six sub-categories. General professional competencies related to the teacher's appearance, attitudes towards students, school authorities and response to students' complaints about his or her treatment of them. It consisted of three sub-categories. Teaching competencies consisted of 17 sub-categories covering a wide range of classroom activities that the teacher and students might undertake.

The results of this study suggested that most science teachers were not following the recommended teaching methods and teaching approaches and the majority of the lessons did not encourage a learner-centered approach as emphasized in the Curriculum Blueprint (1997). Teachers dominated in class activities with little student participation, except in question and answer discourse and during demonstration. Mixed ability teaching, which encourages students with different academic abilities, was evident in some lessons. However, its absence in 46% of all lessons was consistent with the findings in primary school and junior secondary school lessons reported by Tabulawa (1995), Madome (1998), and Letsholo (1996).

Most teachers did not bring lesson plans, lesson notes, or a scheme of work though they were required to do so. A variety of teaching methods including, but not limited to, inquiry, demonstration, or practical work, were not being used on a regular basis and students were not exposed to practical applications of science in everyday life.

In another study, Mogapi and Yandila (2001) sought to find out if: (i) senior secondary school science teachers agreed with the suggested reasons why they did not follow the recommended teaching methods, (ii) science departments were adequately equipped with computers for use by science teachers for computation, record-keeping and word process, (iii) science teachers were computer literate, and (iv) science teachers considered the proposed assessment guidelines for science practical work adequate, suitable and acceptable. A questionnaire was sent to 81 senior secondary school science teachers in Botswana. The results showed that senior secondary school science teachers agreed with the reasons why they did not follow the recommended teaching methods. The reasons were:

- Teaching large classes.
- Having large teaching loads.
- Inadequately prepared to carryout continuous assessment.
- Lack of adequately trained laboratory assistants.
- Feel grieved for being inadequately consulted during the design and development of the new biology syllabus.

The results also showed that:

- most science departments were not adequately equipped with computers for use by science teachers for computation, record-keeping and word process,
- most science teachers were computer literate, and expressed desire to take up special computer courses.
- science teachers considered the proposed assessment guidelines for science practical work to be inadequate

In light of all the results presented above, it was necessary to investigate how the new science syllabi were being taught in the classrooms. This required recording of the classroom observation by means of a video camera so that they can be analysed thoroughly. Except in few instances, the cameral is able to capture everything happening in a lesson.

Population and Sample

The population of the study includes all 27 government and government- sponsored senior secondary schools in Botswana. It is hoped that a more comprehensive report will be made after data from all the 27 schools have been analyzed. The population consists of rural, peri-urban and urban schools; boarding day schools scattered across the country. The study was initiated in 2001 and is expected to be completed at the end of 2002. However, this paper is based on data that have been analyzed from 18 senior secondary schools.

In each school, three classes were selected on the basis that Forms 4 and 5 students were taking a Pure, Single or Double Science, in 80 minute lesson being conducted in the laboratory by a confirmed science teacher in any of the three sciences subjects. General request for permission to carry out the study was sent to all the 27 schools. Once granted, heads of science departments were contacted to identify teachers. A random sample of teachers was selected and the teachers concerned contacted. Then the teachers were briefed about the study. They in turn informed their classes that they would be video-recorded. Arrangements for recording were made in terms of place and time of recording and required teaching aids and materials.

The sample consisted of 54 science teachers of whom 39 were male and 15 female. Teaching experience ranged from 2 to 20 years. Each of the 54 classes consisted of 40 students (50% male and 50% female), with an average of 19 years ranging from 15-21 years. Most were form 4 classes. All the lessons were recorded in subject-specific laboratories.

Instrumentation

The classroom activities may be observed using either checklist, writing while listening, audio recording or video recording-forms of the case study. All these methods possess some benefits and as well as costs; the teacher's expression (eagerness, aggressiveness) as well as the student expression would be missed out in audio recording.

A video cameral was chosen for this study because of its versatility and accuracy in capturing almost all classroom activities. It would reveal the advantages of audio recording for later analysis and also adds a record of body language and other useful indicators. It also gives a wealth of material that can later be used to construct a video film that helps to effectively disseminate the results of the study. The researchers recorded the lessons after receiving professional training in using the video camera. Training involved focusing on every possible activity as well as the operation of the video tape recorder, its installation and manurverbilty in the class. Tape recording was ruled out because it only records the activities that are focused on, rather than all the activities that take place in the classroom during a lesson. Writing on paper in the classroom was also ruled out because the researchers would not be able to note all the activities that take place in an 80-minute lesson.

The video camera was turned on at the beginning of the lesson and turned off at the end without interfering with the normal activities of the lesson. The researchers did not talk or comment on what the students were doing during the lesson. Teachers were briefed on what was going to take place before the recording started and were assured that they would receive a copy of recorded videocassette at the end of the study.

Results of the Study

The recorded lessons were analyzed involving several processes. Firstly, each videotape was transcribed verbally in terms of what was said by the teacher students. Every activity that was undertaken by both the teacher and students was transcribed. After the transcription, the lessons were then analyzed descriptively in order to provide answers to the research questions. The lessons fell into three major categories: (i) Demonstration, (ii) Laboratory, and (iii) Theoretical Presentation. Details and examples of each will be given in a final project report. Here below is a summary of each and overall results.

(i) Demonstration

In a demonstration lesson, the teacher introduced the topic and invited the class to come forward and observe phenomena that he /she performed in their presence. In most cases, the teacher explained to the class each step of the procedure he/she was following, giving reasons and stating precautions. After the demonstration, students were asked what they observed happen. This led to a series of questions and answer session. In few cases, one or two students were asked to repeat the demonstration. This was followed by theoretical discussion of the underlying principles. In few cases, the students were asked to write up the demonstration as if they had carried out. Notes were given and the lesson concluded with the giving of homework. In this case, demonstration was an end in itself. This was commonly done in Double and Single science Lessons.

In two lessons, demonstration preceded practical work. In this case, demonstration helped students to carry out their own experiments.

(ii) Laboratory

In a laboratory lesson the teacher gave a brief introduction and instructions on what the students were to carry out in their investigations. In most cases, the instructions were given as handouts. In some cases, they were written on the chalkboard. In few cases they were dictated. Students were asked to work in-groups of 3-8, depending on the size of the class and availability of equipment. Members of the groups were asked to collect equipment and materials from the teacher's counter. While groups were performing the experiments, the teacher walked around assisting them in their work. In most cases two or three members of the group performed the procedures while others observed or recorded results. At the end of the practical work, one member of each group reported the results and made conclusions of their experiments in front of the class. This usually provoked some discussion, particularly if the results were inconclusive. At the end of the practical work, the teacher or students summarized the lesson. In most cases, home work was given.

This type of lesson was common in Pure Science lessons. This is because students are required to take practical examinations at the end of form 5. Despite this, the lessons fell far too short in inculcating the four major process skills of using and organising techniques, apparatus and materials, observing, measuring and recording, handling experimental observations and data and planning Investigations. Students followed the experimental procedures given by their teachers.

(iii) Theoretical Presentation

The most common lesson was purely theoretical in which the teacher simply lectured to the students who took notes. Question and answer session and some discussion were encouraged. This type of lesson was dry and boring. The use of visual aids was minimal. A lot of notes were either dictated to students or written on the chalkboard for them to copy.

The results showed the following trends in the 54 lessons:

1. Most of the science teachers did not employ the prescribed learner-centered approach in the senior secondary schools science lessons. Only three experienced and expatriate teachers were employing it.
2. Most of the school laboratories were not fully equipped in terms of equipment, furniture, specimen, apparatus, chemicals, etc.
3. Most of the school laboratories were either in disrepair or under construction, as a result, some lessons were held in inappropriate rooms.
4. Schools did not have qualified technicians or at least laboratory assistants to manage the laboratories or assist teachers in class. This is because the schools have not been permitted to high such calibre of people.

5. The science teachers showed little evidence of adequately doing pre-planning for learner-centered approach activities. They did not show any evidence of having a lesson plan in class, except for lesson notes.
6. There was evidence of mixed-ability and differentiated learning approaches in which students took either core or core plus extension content in Pure Sciences of Biology, Chemistry and Physics, Double Science and Single Science. In very few cases students were allowed to work independently or in small groups.
7. Most of the science teachers did not use a variety of highly recommended teaching methods such as inquiry, demonstration, practical work, project work, case study, field trips, discussions, computer guided learning.
8. In most lessons, there was little evidence of increased participation in class of all groups of learners.
9. In some instances, students were being exposed to practical application of science in everyday life, through using the local environment and context.
10. Most of the teachers were not making effort to inculcate the recommended processes skills of using and organizing apparatus and materials, collecting data, handling experimental observations and data, and planning for investigation. Those who did, were very successful in achieving their objectives.
11. Most of the teachers carried out demonstrations as an end in themselves or in preparing the students to carry out their own group or individual practical work.
12. Most of the teachers effectively used a variety of teaching aids in their lessons. These were both commercially and teacher-made aids.
13. The skill of asking questions and giving well-thought out answers was not being developed in students. Most of the questions asked by teachers and students were of low order level.
14. Most of the teachers did not provide a conducive environment for asking and answering questions during the lesson.
15. Since BGCSE syllabi has more content than its predecessor did COSC, science teachers tended to rush through the new syllabi, which must be completed in two years.
16. Despite the insistence of the BGCSE syllabi that hands-on type of learning be implemented, most science teachers did not practice it.
17. Most of the science teachers were not implementing the recommended assessment procedures for course work.

Recommendations

1. The in-service unit of the Ministry of Education, should equip science teachers in order to employ the prescribed learner-centered approach; involving laying emphasis on the science process skills, problem-solving skills and the acquisition of hands-on experience; teacher-centered or a mixture of the two approaches is not being practiced in the senior secondary schools.
2. The University of Botswana should prepare student teachers in order to employ the prescribed learner-centered approach; involving laying emphasis on the science process skills, problem-solving skills and the acquisition of hands-on experience; teacher-centered or a mixture of the two approaches is not being practiced in the senior secondary schools.
3. The Ministry of Education should revamp science laboratories in terms of their structures, furniture, materials and chemicals and human resources so that teaching and learning can take place more effectively.
4. The recorded lessons in this study should be used in both pre- and in-service teacher training programmes so that they can learn from the strengths and weaknesses of other teachers.

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